

CLAIMS:

1. A paint system comprising a paint supply station, a paint supply channel downstream of the paint supply station, the paint supply channel having a number of supply nodes, a paint return channel upstream of the paint supply station, the paint return channel having a number of return nodes, and a number of paint circulation lines, each paint circulation line including a coupling for connecting a paint output nozzle assembly thereto, each paint circulation line being positioned downstream of the paint supply channel at a corresponding supply node, each paint circulation line being positioned upstream of the paint return channel at a corresponding return node, each of said paint circulation lines further comprising a flow induced pressure generating portion for developing a differential pressure in the paint circulation line, the differential pressure being proportional to the magnitude of paint flow therein, each of the pressure generating portions being selected to generate sufficient differential pressure sufficient to provide an operative pressure differential at a corresponding paint output nozzle assembly, wherein each paint circulation line is substantially free of any component of sufficient size to cause accumulation of settled solids from a paint mixture to cause pressure changes to a degree requiring that the system be recalibrated or to cause settled solids to be deposited on a painted surface to a degree requiring remedial repair.
2. A system as defined in claim 1 wherein each flow induced differential pressure generating portion includes a length of tubing.
3. A system as defined in claim 2 wherein the tubing is coiled.
4. A system as defined in claim 1 wherein the paint output nozzle assembly is a paint spray gun.

5. A system as defined in claim 1 wherein the coupling is a colour change valve, or a manual flow through regulator with or without a quick disconnect.
6. A paint system comprising a paint supply station, a paint supply channel downstream of the paint supply station, the paint supply channel having a number of supply nodes, a paint return channel upstream of the paint supply station, the paint return channel having a number of return nodes and a number of paint circulation lines, each paint circulation line including a coupling for connecting a paint output nozzle assembly thereto, each paint circulation line being positioned downstream of the paint supply channel at a corresponding supply node, each paint circulation line being positioned upstream of the paint return channel at a corresponding return node, each of said paint circulation lines further comprising a flow induced pressure generating portion for developing a differential pressure in the paint circulation line, the differential pressure being proportional to the magnitude of paint flow therein, each of the pressure generating portions being selected to generate sufficient differential pressure sufficient to provide an operative pressure differential at a corresponding paint output nozzle assembly, wherein the pressure differential of all paint circulation lines is such that the design flow rate in every paint circulation line is substantially obtained in a stable and robust fashion, wherein changes in viscosity, provided the flow stays in the laminar flow zone, will cause the design flow rates in each and every paint circulation line to be substantially maintained.

7. A paint circulation system for supplying a paint mixture to a paint booth in a manufacturing operation, the paint circulation system comprising a number of paint drop lines supplying paint to a number of paint spray gun assemblies, each paint drop line including at least one colour change valve for connecting at least one paint spray gun assembly thereto, each paint spray gun assembly being operative to spray a paint mixture received from the corresponding paint drop line at an operative flow rate, each paint drop line being positioned downstream of a paint supply node and upstream of a corresponding paint return node, each of said paint drop lines further comprising a means for generating differential pressure according to the operative flow rate, wherein each paint drop line is substantially free of any component or dead spot of sufficient size to cause accumulation of settled solids from a paint mixture to cause pressure changes to a degree requiring that the system be recalibrated or to cause settled solids to be deposited on a painted surface to a degree requiring remedial repair thereof.
8. A paint circulation system for supplying a paint mixture to a paint booth in an automobile manufacturing operation, the paint circulation system comprising a number of paint drop lines, each including a colour change valve for connecting at least one paint spray gun assembly thereto, each paint drop line being positioned downstream of a paint supply channel and upstream of a paint return channel, each of said paint drop lines further comprising a means for generating differential pressure according to an operative flow rate for the corresponding at least one spray gun assembly, wherein each paint drop line is substantially free of any component or dead spot of sufficient size to cause accumulation of settled solids from a paint mixture to cause pressure changes to a degree requiring that the system be recalibrated or to cause settled solids to be deposited on a painted surface to a degree requiring remedial repair thereof, wherein each paint drop line is free of pressure regulators, pressure reducing valves, pressure gauge assemblies, tees, standpipes, isolation valves, isolation diaphragms, or a

combination thereof.

9. A paint circulation system for supplying a paint mixture to a paint booth in a manufacturing operation, the paint circulation system comprising a number of paint drop lines, each including a colour change valve for connecting a paint spray gun assembly thereto, each paint drop line being positioned downstream of a paint supply node and upstream of a paint return node, each of said paint drop lines further comprising a means for generating differential pressure according to a magnitude of paint flowing therein and under low shear flow conditions, wherein each paint drop line is substantially free of one or more sources of shear induced damage to additives contained in a paint mixture resulting in inconsistencies in a painted surface to a degree requiring remedial repair thereof.
10. A method of supplying a paint mixture to a paint booth in a manufacturing operation, comprising the steps of:
 - providing a number of paint drop lines between a number of paint supply nodes and a number of paint return nodes;
 - providing a coupling to connect at least one spray gun assembly to each paint drop line;
 - determining an operative pressure condition in each drop line by determining an operative pressure differential between the corresponding paint supply node and the corresponding paint return node, in order to provide an operating pressure for the at least one spray gun assembly;
 - installing a flow induced differential pressure generator in each drop line; and adjusting each differential pressure generator to satisfy the operative pressure conditions, and under low shear flow conditions, wherein each paint drop line is substantially free of any source of shear induced damage to additives contained in a paint mixture resulting in inconsistencies in a painted surface to a degree requiring remedial repair thereof.

11. A method as defined in claim 10 wherein the coupling is a colour change valve, a manual regulator, a quick connect, or a combination thereof.
12. A method of supplying a paint mixture to a paint booth in an automobile manufacturing operation, comprising the steps of:
 - providing a number of paint drop lines between a paint supply channel and a paint return channel;
 - providing a coupling to connect at least one a spray gun assembly to each paint drop line;
 - determining operative pressure conditions by determining a pressure differential between the paint supply channel and the paint return channel to provide an operating pressure for each spray gun assembly ;
 - installing a flow induced differential pressure generator in each paint drop line;
 - adjusting each differential pressure generator to satisfy the operative pressure conditions; and
 - providing that each paint drop line is substantially free of one or more components or dead spots of sufficient size to cause accumulation of settled solids from a paint mixture to cause pressure changes to a degree requiring that the system be recalibrated or to cause settled solids to be deposited on a painted surface to a degree requiring remedial repair thereof.
13. A system as defined in claim 1 wherein the differential pressure in each paint circulation line is produced entirely by a combination of differential sub-pressure including a first sub-pressure produced by the flow induced pressure generating portion, a second sub-pressure produced by paint circulation line and the coupling and without a pressure regulator, or pressure reducing valve or a pressure gauge assembly or a combination thereof.

14. A paint circulation system for a painting line, comprising a supply channel, a return channel and a plurality of drop lines downstream of the supply channel and upstream of the return channel, and control means located in each drop line for controlling a flow rate of paint through each drop line, wherein the control means is operative to adjust the flow rate according to a flow controlling pressure differential, and wherein the flow controlling pressure differential is the pressure differential across the drop line between the supply channel and the return channel.
15. A paint circulation system for a painting line, comprising a supply channel, a return channel and a plurality of drop lines downstream of the supply channel and upstream of the return channel, and control means located in each drop line for controlling a flow rate of paint through each drop line, wherein the control means is operative to adjust the flow rate according to a flow controlling pressure differential, and wherein the flow controlling pressure differential is the pressure differential across the drop line between the supply channel and the return channel, wherein changes to viscosity in the paint do not result in changes to the system requiring recalibration between paint drop lines.
16. A paint circulation system for a painting line, comprising a supply channel, a return channel and a plurality of drop lines downstream of the supply channel and upstream of the return channel, a paint pump means for circulating paint through the supply channel, the drop lines and the return channel with a corresponding flow rate through each drop line, and means for establishing a flow controlling pressure differential between the supply channel and the return channel in each drop line which is directly proportional to the paint flow rate, wherein a change in the flow controlling pressure differential in a given drop line causes a corresponding proportional change in the paint flow rate through the given drop line.

17. A paint circulation system for an automotive painting line, comprising a supply channel, a return channel and a plurality of drop lines downstream of the supply channel and upstream of the return channel, a paint pump means for circulating paint through the supply channel, the return channel and at a drop line paint flow rate through the drop lines, and means for limiting changes to the drop line flow rate in a given drop line to within a proportional change in a flow controlling pressure differential in the corresponding drop line between the supply channel and the return channel.
18. A method of balancing a circulation system for a painting line, comprising the steps of:
 - providing a supply channel, a return channel and a plurality of drop lines downstream of the supply channel and upstream of the return channel;
 - providing a paint pumping unit to circulate paint through the supply channel, the drop lines and the return channel and at at least one drop line paint flow rate through each of said drop lines;
 - maintaining a flow controlling pressure differential in each drop line at a level substantially equal to the pressure differential in the drop line between the supply channel and the return channel; and
 - making a proportional adjustment to flow rate through the drop line according to a change in the flow controlling pressure differential.
19. A method of balancing a circulation system for an automotive painting line, comprising the steps of:
 - providing a supply channel, a return channel and a plurality of drop lines downstream of the supply channel and upstream of the return channel;
 - providing a paint pumping unit to circulate paint through the supply channel, the drop lines and the return channel and at at least one drop line paint flow rate through each of said drop lines;

maintaining a flow controlling pressure differential in each drop line at a level substantially equal to the pressure differential in the drop line between the supply channel and the return channel; and

limiting changes to the drop line flow rate in a given drop line to within a proportional change in a flow controlling pressure differential in the corresponding drop line between the supply channel and the return channel.

20. A method of supplying a paint mixture to a paint booth in a manufacturing operation, comprising:
 - a step for providing a number of paint drop lines between a number of paint supply nodes and a number of paint return nodes;
 - a step for providing a coupling to connect at least one spray gun assembly to each paint drop line;
 - a step for determining an operative pressure condition in each drop line by determining an operative pressure differential between the corresponding paint supply node and the corresponding paint return node, in order to provide an operating pressure for the at least one spray gun assembly;
 - a step for installing a flow induced differential pressure generator in each drop line; and adjusting each differential pressure generator to satisfy the operative pressure conditions, and under low shear flow conditions, wherein each paint drop line is substantially free of any source of shear induced damage to additives contained in a paint mixture resulting in inconsistencies in a painted surface to a degree requiring remedial repair thereof.